WHAT IS CLAIMED IS:

1. A projection optical system for use in an image projection apparatus illuminating a lightbulb forming an image in accordance with a modulating signal with illumination light from a light source, the projection optical system comprising:

first and second optical systems arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream side of the lightbulb,

wherein the first optical system includes at least one dioptric system and has positive power;

the second optical system includes at least one reflecting surface having power and has positive power; and

the image formed by the lightbulb is formed as an intermediate image in the optical path, and the intermediate image is magnified and projected.

2. The projection optical system as claimed in claim 1, further comprising a negative-power optical element for bringing a position where the intermediate image is formed close to a positive-power reflecting surface of the second optical system, the negative-power optical element being provided on an upstream side of the intermediate image in the optical path.

3. The projection optical system as claimed in claim 2, wherein the second optical system includes at least the positive-power reflecting surface and a negative-power reflecting surface.

4. The projection optical system as claimed in claim 1, wherein the second optical system includes at least one reflecting surface including a free-form surface.

5. The projection optical system as claimed in claim 1, wherein a reflecting surface that reflects a light beam after forming the intermediate image first includes a free-form surface.

6. The projection optical system as claimed in claim 1, wherein the first optical system includes only the dioptric system.

7. The projection optical system as claimed in claim 6, wherein the at least one dioptric system includes a refracting surface of an aspheric figure.

8. The projection optical system as claimed in claim 1, wherein the first optical system includes a reflecting surface having a rotational symmetry

axis and the dioptric system.

9. The projection optical system as claimed in claim 8, wherein the at least one dioptric system includes a refracting surface of an aspheric figure.

10. An image projection apparatus that illuminates a lightbulb forming an image in accordance with a modulating signal with illumination light from a light source, the image projection apparatus comprising:

a projection optical system,

the projection optical system comprising first and second optical systems arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream side of the lightbulb,

wherein the first optical system includes at least one dioptric system and has positive power;

the second optical system includes at least one reflecting surface having power and has positive power; and

the image formed by the lightbulb is formed as an intermediate image in the optical path, and the intermediate image is magnified and projected by the projection optical system.

11. A magnification projection optical system that guides a light beam from an image display panel to a screen in an upstream-downstream direction, projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of an image displayed on the image display panel, the magnification projection optical system comprising:

a reflection optical system; and

a transmission optical system,

wherein the reflection optical system includes a plurality of reflecting surfaces having power and includes at least one rotationally asymmetric reflecting surface; and

the transmission optical system includes a transmitting surface having refractive power and includes at least one aspheric surface.

12. The magnification projection optical system as claimed in claim 11, wherein a diaphragm is provided between a first surface of the transmission optical system from an upstream side thereof and a first surface of the reflection optical system from a downstream side thereof so that an image of the diaphragm is formed with negative reducing magnification by an optical element provided on a downstream side of the diaphragm.

13. The magnification projection optical system as claimed in claim 11, wherein the rotationally asymmetric reflecting surface is positioned at a furthest downstream end of the second optical system in a projection optical path.

14. The magnification projection optical system as claimed in claim 11, wherein the transmission optical system includes a rotationally asymmetric transmitting surface having refractive power.

15. The magnification projection optical system as claimed in claim 11, wherein the transmission optical system has an optical axis set to be decentered with respect to a position of the image display panel in a plane including a light guide path.

16. The magnification projection optical system as claimed in claim 11, wherein the reflection optical system is formed as a unit.

17. A magnification projection optical system that guides a light beam from an image display panel to a screen in an upstream-downstream direction, projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of an image displayed on the image display panel, the magnification projection optical system comprising:

a transmission optical system including a plurality of transmitting surfaces;

a reflection optical system including a plurality of reflecting surfaces; and

a diaphragm,

wherein one of the reflecting surfaces, on which a light beam passing through the diaphragm is made incident first, has negative power.

18. The magnification projection optical system as claimed in claim 17, wherein another one of the reflecting surfaces, which another one is subsequent to the one having negative power, has positive power.

19. The magnification projection optical system as claimed in claim 17, wherein:

the reflecting surfaces of the reflection optical system have power and include at least one rotationally asymmetric reflecting surface; and

the transmitting surfaces of the transmission optical system have refractive power and include at least one aspheric surface.

20. The magnification projection optical system as claimed in claim 19, wherein the rotationally asymmetric reflecting surface is positioned at a furthest downstream end of the second optical system in a projection optical path.

21. The magnification projection optical system as claimed in claim 17, wherein the transmission optical system includes a rotationally asymmetric transmitting surface having refractive

power.

22. The magnification projection optical system as claimed in claim 17, wherein the transmission optical system has an optical axis set to be decentered with respect to a position of the image display panel in a plane including a light guide path.

23. The magnification projection optical system as claimed in claim 17, wherein the reflection optical system is formed as a unit.

24. A magnification projection optical system that guides a light beam from an image display panel to a screen in an upstream-downstream direction,

projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of an image displayed on the image display panel, wherein:

a position and a shape of an intermediate image of the image display panel formed with negative magnification by light beams traveling from the image display panel to the screen are substantially identical to a position and a shape, respectively, of an intermediate image of the screen formed with negative magnification by light beams traveling from the screen to the image display panel.

25. The magnification projection optical system as claimed in claim 24, comprising:

a reflection optical system including a plurality of reflecting surfaces; and

a transmission optical system including a plurality of transmitting surfaces.

26. The magnification projection optical system as claimed in claim 25, further comprising a diaphragm,

wherein one of the reflecting surfaces, on which a light beam passing through the diaphragm is made incident first, has negative power.

27. The magnification projection optical system as claimed in claim 26, wherein another one of the reflecting surfaces, which another one is subsequent to the one having negative power, has positive power.

28. The magnification projection optical system as claimed in claim 25, wherein:

the reflecting surfaces of the reflection optical system have power and include at least one rotationally asymmetric reflecting surface; and

the transmitting surfaces of the

transmission optical system have refractive power and include at least one aspheric surface.

29. The magnification projection optical system as claimed in claim 28, wherein the rotationally asymmetric reflecting surface is positioned at a furthest downstream end of the second optical system in a projection optical path.

30. The magnification projection optical system as claimed in claim 25, wherein the transmission optical system includes a rotationally asymmetric transmitting surface having refractive power.

31. The magnification projection optical

system as claimed in claim 25, wherein the transmission optical system has an optical axis set to be decentered with respect to a position of the image display panel in a plane including a light guide path.

32. The magnification projection optical system as claimed in claim 25, wherein the reflection optical system is formed as a unit.

33. A magnification projection apparatus that: displays an image on an image display panel; illuminates the image display panel with light from a light source; and by a magnification projection optical system, guides a light beam from the image display panel to a screen in an upstream-downstream direction, projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of the image displayed on

the image display panel, wherein:

the magnification projection optical system comprises a reflection optical system and a transmission optical system;

the reflection optical system includes a plurality of reflecting surfaces having power and includes at least one rotationally asymmetric reflecting surface; and

the transmission optical system includes a transmitting surface having refractive power and includes at least one aspheric surface.

34. A magnification projection apparatus that: displays an image on an image display panel; illuminates the image display panel with light from a light source; and by a magnification projection optical system, guides a light beam from the image display panel to a screen in an upstream-downstream direction, projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of the image displayed on the image display panel, wherein:

the magnification projection optical system comprises:

a transmission optical system including a plurality of transmitting surfaces;

a reflection optical system including a plurality of reflecting surfaces; and

a diaphragm; and

one of the reflecting surfaces, on which a light beam passing through the diaphragm is made incident first, has negative power.

35. A magnification projection apparatus that: displays an image on an image display panel; illuminates the image display panel with light from a light source; and by a magnification projection optical system, guides a light beam from the image display panel to a screen in an upstream-downstream direction, projects the light beam from a direction inclined to a normal of the screen, and forms on the screen a magnified version of the image displayed on the image display panel, wherein:

a position and a shape of an intermediate

image of the image display panel formed with negative magnification by light beams traveling from the image display panel to the screen are substantially identical to a position and a shape, respectively, of an intermediate image of the screen formed with negative magnification by light beams traveling from the screen to the image display panel.

36. A projection optical system, comprising:

a first optical system including at least one dioptric system and having positive power; and

a second optical system including one or more reflecting surfaces having power, the second optical system having positive power as a whole,

wherein the first and second optical systems are arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream side of an object surface;

an object image is temporarily formed as an intermediate image, and thereafter, is formed as a

normal image; and

with respect to an optical axis of an optical element positioned at a furthest upstream end of the first optical system and having refractive power, at least one of other optical elements is shifted or tilted.

37. The projection optical system as claimed in claim 36, wherein the reflecting surfaces of the second optical system includes at least one free-form surface.

38. The projection optical system as claimed in claim 37, wherein only one of the reflecting surfaces of the second optical system, which one is positioned furthest on a side of a position where the normal image is formed, is the free-form surface.

39. The projection optical system as claimed in claim 36, wherein one of the reflecting surfaces of the second optical system, which one has positive power and from which one a light beam made incident on the second optical system is reflected first, is rotationally symmetric.

40. The projection optical system as claimed in claim 39, wherein the one of the reflecting surfaces which one is rotationally symmetric is a spherical reflecting surface.

41. The projection optical system as claimed in claim 36, wherein the first optical system includes only the dioptric system.

42. The projection optical system as claimed in claim 41, wherein the dioptric system of the first optical system excludes an aspheric surface figure.

43. A projection optical system, comprising:

a first optical system including at least one dioptric system and having positive power; and

a second optical system including one or more reflecting surfaces having power, the second optical system having positive power as a whole,

wherein the first and second optical systems are arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream side of an object surface;

an object image is temporarily formed as an intermediate image, and thereafter, is formed as a normal image; and

in the first optical system, with respect to an optical axis of one of optical elements of the

first optical system, which one is positioned at a furthest upstream end of the first optical system and has refractive power, the other optical elements are prevented from being tilted.

44. The projection optical system as claimed in claim 43, wherein:

the first optical system includes a plurality of groups; and

at least one of the groups is shifted.

45. The projection optical system as claimed in claim 43, wherein the reflecting surfaces of the second optical system includes at least one free-form surface.

46. The projection optical system as claimed in claim 45, wherein only one of the reflecting surfaces of the second optical system, which one is positioned furthest on a side of a position where the normal image is formed, is the free-form surface.

47. The projection optical system as claimed in claim 43, wherein one of the reflecting surfaces of the second optical system, which one has positive power and from which one a light beam made incident on the second optical system is reflected first, is rotationally symmetric.

48. The projection optical system as claimed in claim 47, wherein the one of the reflecting surfaces which one is rotationally symmetric is a spherical reflecting surface.

49. The projection optical system as claimed in claim 43, wherein the first optical system includes only the dioptric system.

50. The projection optical system as claimed in claim 49, wherein the dioptric system of the first optical system excludes an aspheric surface figure.

51. An image projection apparatus that, by a projection optical system, guides a light beam from an image display panel to a screen and forms on the screen a normal version of the image displayed on the image display panel, wherein:

the projection optical system comprises:

a first optical system including at least one dioptric system and having positive power; and

a second optical system including one

or more reflecting surfaces having power, the second optical system having positive power as a whole;

the first and second optical systems are arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream side of an object surface;

an object image is temporarily formed as an intermediate image, and thereafter, is formed as a normal image; and

with respect to an optical axis of an optical element positioned at a furthest upstream end of the first optical system and having refractive power, at least one of other optical elements is shifted or tilted.

52. An image projection apparatus that, by a projection optical system, guides a light beam from an image display panel to a screen and forms on the screen a normal version of the image displayed on the image display panel, wherein:

the projection optical system comprises:

a first optical system including at least one dioptric system and having positive power; and

a second optical system including one or more reflecting surfaces having power, the second optical system having positive power as a whole;

the first and second optical systems are arranged along an optical path defining an upstream-downstream direction in an order described from upstream to downstream on a downstream end of an object surface;

an object image is temporarily formed as an intermediate image, and thereafter, is formed as a normal image; and

in the first optical system, with respect to an optical axis of one of optical elements of the first optical system, which one is positioned at a furthest upstream end of the first optical system and has refractive power, the other optical elements are prevented from being tilted.

53. A projection optical system guiding and

projecting a light beam from a projected object surface onto a projection surface in an upstream-downstream direction through a transmission dioptric system and a reflection dioptric system of one or two reflecting mirrors, wherein:

the transmission dioptric system includes a plurality of transmission refractive elements;

substantial telecentricity is provided from the projected object surface up to a first surface of the transmission dioptric system;

an intermediate image surface of the projected object surface is positioned closer to the reflection dioptric system than to the transmission dioptric system, and an intermediate image on the intermediate image surface is formed as a normal image on the projection surface via the reflecting mirrors;

the reflecting mirrors include at least one anamorphic polynomial free-form surface having different vertical and lateral powers;

a light beam from the reflection dioptric system to the projection surface is guided at an angle to a normal of the projection surface; and

the transmission dioptric system is decentered with respect to a normal of the projected

object surface, and the transmission refractive elements of the transmission dioptric system are prevented from being decentered with respect to each other.

54. The projection optical system as claimed in claim 53, wherein:

the reflection dioptric system includes first and second reflecting mirrors arranged in an order described from upstream to downstream on a downstream side of the transmission dioptric system;

the intermediate image surface of the projected object surface is positioned between the first and second reflecting mirrors; and

the first reflecting mirror includes an axially symmetric reflecting surface having negative power, and the second reflecting mirror includes an anamorphic polynomial free-form surface having different vertical and lateral powers.

55. The projection optical system as claimed in claim 53, comprising an anamorphic polynomial free-form surface having different vertical and lateral powers in the transmission dioptric system as a part correcting an aspect ratio of the intermediate image of the projected object surface.

56. The projection optical system as claimed in claim 53, wherein an NA in the transmission dioptric system is greater on an upstream side thereof than on the downstream side thereof.

57. The projection optical system as claimed in claim 53, wherein the intermediate image surface is tilted and curved with respect to a principal ray of a light beam emitted from a center of the projected object surface.

58. The projection optical system as claimed in claim 53, wherein a principal ray emitted from a center of the projected object surface and a principal ray emitted from a margin of the projected object surface are parallel to each other in a last surface of the transmission dioptric system.

59. The projection optical system as claimed in claim 53, wherein magnification of the intermediate image falls in a range of 1 to 5.

60. The projection optical system as claimed in claim 53, wherein magnification of projection is 40X or higher.

61. The projection optical system as

claimed in claim 60, wherein an angle of projection to the projection surface is 5° or greater.

62. A projection optical system guiding and projecting a light beam from a projected object surface onto a projection surface in an upstream-downstream direction through a transmission dioptric system and a reflection dioptric system of one or two reflecting mirrors, wherein:

the transmission dioptric system includes a plurality of transmission refractive elements;

substantial telecentricity is provided from the projected object surface up to a first surface of the transmission dioptric system;

an intermediate image surface of the projected object surface is positioned closer to the reflection dioptric system than to the transmission dioptric system, and an intermediate image on the intermediate image surface is formed as a normal image on the projection surface via the reflecting mirrors;

the reflecting mirrors include at least one

anamorphic polynomial free-form surface having different vertical and lateral powers;

a light beam from the reflection dioptric system to the projection surface is guided at an angle to a normal of the projection surface; and

the transmission dioptric system is decentered with respect to a normal of the projected object surface, and the transmission refractive elements of the transmission dioptric system are prevented from being decentered with respect to each other at a group unit level.

63. The projection optical system as claimed in claim 62, wherein:

the reflection dioptric system includes first and second reflecting mirrors arranged in an order described from upstream to downstream on a downstream side of the transmission dioptric system;

the intermediate image surface of the projected object surface is positioned between the first and second reflecting mirrors; and

the first reflecting mirror includes an

axially symmetric reflecting surface having negative power, and the second reflecting mirror includes an anamorphic polynomial free-form surface having different vertical and lateral powers.

64. The projection optical system as claimed in claim 62, comprising an anamorphic polynomial free-form surface having different vertical and lateral powers in the transmission dioptric system as a part correcting an aspect ratio of the intermediate image of the projected object surface.

65. The projection optical system as claimed in claim 62, wherein an NA in the transmission dioptric system is greater on an upstream side thereof than on the downstream side thereof.

66. The projection optical system as claimed in claim 62, wherein the intermediate image surface is tilted and curved with respect to a principal ray of a light beam emitted from a center of the projected object surface.

67. The projection optical system as claimed in claim 62, wherein a principal ray emitted from a center of the projected object surface and a principal ray emitted from a margin of the projected object surface are parallel to each other in a last surface of the transmission dioptric system.

68. The projection optical system as claimed in claim 62, wherein magnification of the intermediate image falls in a range of 1 to 5.

69. The projection optical system as claimed in claim 62, wherein magnification of projection is 40X or higher.

70. The projection optical system as claimed in claim 69, wherein an angle of projection to the projection surface is 5° or greater.

71. An image projection apparatus magnifying an image displayed on a projected object surface and projecting the magnified image on a projection surface by a projection optical system, wherein:

the projection optical system guides and projects a light beam from the projected object surface onto the projection surface in an upstream-downstream direction through a transmission dioptric system and a reflection dioptric system of one or two reflecting mirrors;

the transmission dioptric system includes a plurality of transmission refractive elements;

substantial telecentricity is provided from the projected object surface up to a first surface of the transmission dioptric system;

an intermediate image surface of the projected object surface is positioned closer to the reflection dioptric system than to the transmission dioptric system, and an intermediate image on the intermediate image surface is formed as a normal image on the projection surface via the reflecting mirrors;

the reflecting mirrors include at least one anamorphic polynomial free-form surface having different vertical and lateral powers;

a light beam from the reflection dioptric system to the projection surface is guided at an angle to a normal of the projection surface; and

the transmission dioptric system is decentered with respect to a normal of the projected object surface, and the transmission refractive elements of the transmission dioptric system are prevented from being decentered with respect to each other.

72. The image projection apparatus as claimed in claim 71, wherein the image projection apparatus is of a front projector type.

73. The image projection apparatus as claimed in claim 71, wherein the image projection apparatus is of a rear projector type, comprising a folding mirror folding back an imaging optical path.

74. An image projection apparatus magnifying an image displayed on a projected object surface and projecting the magnified image on a projection surface by a projection optical system, wherein:

the projection optical system guides and projects a light beam from the projected object surface onto the projection surface in an upstream-downstream direction through a transmission dioptric system and a reflection dioptric system of one or two

reflecting mirrors;

the transmission dioptric system includes a plurality of transmission refractive elements;

substantial telecentricity is provided from the projected object surface up to a first surface of the transmission dioptric system;

an intermediate image surface of the projected object surface is positioned closer to the reflection dioptric system than to the transmission dioptric system, and an intermediate image on the intermediate image surface is formed as a normal image on the projection surface via the reflecting mirrors;

the reflecting mirrors include at least one anamorphic polynomial free-form surface having different vertical and lateral powers;

a light beam from the reflection dioptric system to the projection surface is guided at an angle to a normal of the projection surface; and

the transmission dioptric system is decentered with respect to a normal of the projected object surface, and the transmission refractive elements of the transmission dioptric system are prevented from being decentered with respect to each other at a group unit level.

75. The image projection apparatus as claimed in claim 74, wherein the image projection apparatus is of a front projector type.

76. The image projection apparatus as claimed in claim 74, wherein the image projection apparatus is of a rear projector type, comprising a folding mirror folding back an imaging optical path.